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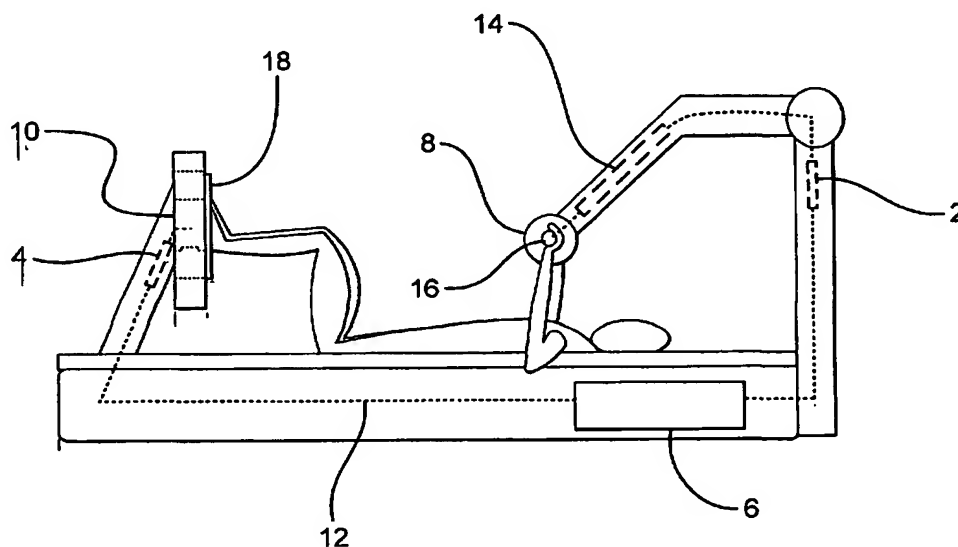
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[Continued on next page]

(54) Title: APPARATUS AND METHOD FOR MUSCULAR STIMULATION



(57) Abstract: Apparatus for muscular stimulation of a user comprises a pressure sensor (2, 4), a control unit (6) to which pressure values sensed by the pressure sensor are fed, and a vibrational stimulator (8, 10) for applying vibrational stimulation. The vibrational stimulator is activated by the control unit in response to the pressure sensor sensing an applied pressure which exceeds a threshold pressure value.

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APPARATUS AND METHOD FOR MUSCULAR STIMULATION

The present invention relates to apparatus and a method for muscular stimulation, in particular apparatus and a method for
5 muscular stimulation by applying vibrational stimulation.

A muscle will undergo reflex contractions when stimulated by the application of mechanical vibrations, in a similar way to voluntary muscle contractions due to physical exertion.
10 Accordingly, devices are known for muscular stimulation by the application of mechanical vibrations. Such devices can be useful for athletic training, since improved muscle tone of a user can be achieved without physical exercise, for example in the home, and in a shorter period of time than could be
15 achieved by physical exercise. Such devices can also be of therapeutic use during recovery of a user from, for example, an accident or surgery, and have been shown to be effective in increasing bone density. However, such devices suffer from the drawback that they require no physical exertion by the
20 user, and hence contribute little to the fitness of the user, and provide a stimulus which is not determined by the physical exertion of the user.

The present invention seeks to provide apparatus and a method
25 for overcoming the drawbacks of the prior art.

According to the present invention there is provided apparatus for muscular stimulation of a user, which apparatus comprises a pressure sensor, a control unit to which pressure values
30 sensed by the pressure sensor are fed, and a vibrational stimulator for applying vibrational stimulation, wherein the vibrational stimulator is activated by the control unit in response to the pressure sensor sensing an applied pressure

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which exceeds a threshold pressure value.

The apparatus according to the present invention thus provides vibrational stimulation to a user in response to the pressure sensor sensing an applied pressure by the user above a threshold value. Thus, the user must expend a certain amount of physical effort in order to activate the vibrational stimulator, the amount of physical effort required being determined by the level at which the threshold pressure value is set.

Preferably, the vibrational stimulator is deactivated when the pressure sensor ceases to sense an applied pressure which exceeds the threshold pressure value. In this way, the user must continue to apply a pressure above the threshold value in order for the vibrational stimulator to remain activated, and thereby provide vibrational stimulation to the muscles of the user.

The apparatus according to the present invention may conveniently take the form of exercise apparatus, for example of the type found in a gym.

The apparatus may comprise one or more pressure sensors, and preferably comprises a first set of pressure sensors for detecting pressure applied through the hands of a user, and/or a second set of pressure sensors for detecting pressure applied through the feet of a user. The first and second sets of pressure sensors may each respectively comprise one or more individual pressure sensors. More preferably, the apparatus comprises both said first and second sets of pressure sensors.

For example, the first set of pressure sensors may detect

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pressure applied to a bar against which a user can push or pull with their hands. The second set of pressure sensors may detect pressure applied to a plate against which a user can push with their feet.

5

The pressure sensor may suitably comprise, for example, a strain gauge.

The apparatus according to the present invention may be
10 designed for use by a user supine, or in a sitting or standing position.

The pressure sensor senses the applied pressure, which pressure value is fed to the control unit. The control unit,
15 controls the operation of the apparatus and may be a central processing unit, or other suitable computer hardware. Thus, the control unit receives pressure values sensed by the pressure sensor, preferably stores the threshold pressure value, and activates, and preferably deactivates, the
20 vibrational stimulator by comparing the pressure values received from the pressure sensor with the stored threshold pressure value. The control unit may perform other functions, for example it may run software which allows a user to tailor the apparatus to individual requirements, such as frequency,
25 amplitude, direction and other characteristics of vibrations generated by the vibrational stimulator. The control unit may also store information concerning use of the apparatus by a user in a particular session, for example for later reading by a user to compare performance data from one session using
30 the apparatus with another, or for providing real time data on display means for viewing during use of the apparatus by a user.

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The apparatus according to the present invention also comprises a vibration stimulator for applying vibrational stimulation. The apparatus preferably comprises a corresponding number of vibration stimulators and pressure
5 sensors, i.e. in the preferred embodiments referred to above having first and second sets of pressure sensors, the apparatus will comprise corresponding first and second vibration sensors. In this way, the pressure sensor(s) and vibrational stimulator(s) may be located in the same unit(s),
10 i.e. the unit(s) to which a user applies pressure during use of the apparatus. Thus, in the preferred embodiments referred to above, a first vibrational stimulator may be associated with the first set of pressure sensors for detecting pressure applied through the hands of a user, and/or a second
15 vibrational stimulator may be associated with the second set of pressure sensors for detecting pressure applied through the feet of a user.

In the particularly preferred embodiment referred to above,
20 the first set of pressure sensors and first vibrational stimulator for application of pressure through the hands of a user may conveniently be associated with a bar against which a user can push with their hands. The second set of pressure sensors and second vibrational stimulator for application of
25 pressure through the feet of a user may, for example, conveniently be associated with a plate against which a user can push with their feet. Thus, when the user applies a pressure to the first and second pressure sensors which exceeds the threshold pressure stored by the control unit, by
30 applying pressure to the first set of pressure sensors through their arms, and to the second set of pressure sensors through their legs, their arms and legs will receive vibrational stimulation from the first and second vibrational stimulators

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respectively.

The vibrational stimulator(s) can preferably deliver vibrational stimulation to a user in a plurality of amplitudes, frequencies and directions. More preferably, the amplitude, frequency and direction of vibration may be tailored by a user via the control unit. Each vibrational stimulator may comprise one or more individual vibration engines, which may be controlled electronically according to parameters stored by the control unit. The vibrational parameters may be manually set by a user prior to use of the apparatus.

The vibrational stimulator(s) may provide vibrational stimulation to a user either via a unit which remains substantially stationary relative to the user, or which can reciprocally move relative to a user, for example in response to the pressure sensor sensing an applied pressure which exceeds the threshold pressure. For example, in the preferred embodiment referred to above, the bar to which a user can apply pressure through their hands may be reciprocally moveable relative to the user, reciprocal movement of the bar being activated in response to the pressure sensor sensing an applied pressure which exceeds the threshold pressure, as for activation of the vibrational stimulator. Similarly, in the aforementioned preferred embodiment, the plate to which a user can apply pressure through their feet may be reciprocally moveable, activated in the same way as the bar.

In those embodiments in which the vibrational stimulator(s) provide vibrational stimulation to a user via a unit which is reciprocally moveable, the reciprocal movement may be, for example, substantially towards and away from the user in the

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plane of symmetry of the user, laterally in a plane substantially orthogonal to the plane of symmetry of the user, a combination of movements in both of said planes, circular movement in one or both of said planes, or a combination of
5 any of such movements. Preferably, the direction(s) of the movement may be predetermined by the user, for example by pre-programming the control unit (e.g. via a touch screen display), as preferably may also the speed and magnitude of the reciprocal movement.

10

Thus, in use, a user of the apparatus according to the present invention applies an initial pressure to be sensed by the pressure sensor. The initial pressure is preferably the maximum pressure which the user can apply at that instant.
15 The pressure sensor senses the initial pressure value, which is stored by the control unit. A threshold pressure value is then determined based upon the initial pressure value. The threshold pressure value may be any value from 0% (i.e. no pressure is required by a user to activate vibrational
20 stimulation) to 100% (i.e. vibrational stimulation is only activated when a pressure equal to or exceeding the initial pressure value is sensed) of the initial pressure value, for example from 50 to 90% of the initial pressure value, or a narrower range of for example 70 to 80%. The threshold
25 pressure value may be automatically set by the control unit, or may be manually set by the user.

Subsequently, each time the pressure sensor senses a pressure applied by the user which exceeds the threshold pressure
30 value, the control unit activates the vibrational stimulator. Preferably, as referred to above, when the pressure sensor senses that the pressure applied by the user has dropped below the threshold value, the control unit deactivates the

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vibrational stimulator. Thus, the user will only receive vibrational stimulation when sufficient pressure is applied to activate the vibrational stimulator, according to the threshold pressure value stored by the control unit, for example as previously manually set by the user.

According to the present invention there is thus also provided a method for muscular stimulation of a user, which method comprises the user applying an initial pressure which is sensed by a pressure sensor, recording the initial pressure value sensed by the pressure sensor, and applying vibrational stimulation to the user by a vibrational stimulator in response to the user applying pressure to the pressure sensor which exceeds a threshold pressure value determined by the initial pressure value.

In the method of the present invention, the vibrational stimulation may be provided to the user via a unit which reciprocally moves relative to the user in response to the user applying pressure to the pressure sensor which exceeds the threshold pressure value.

The apparatus and method according to the present invention thus have utility for exercising muscles, either as part of a fitness regime, or a recovery program of a user from surgery or illness. The apparatus and method according to the present invention have the particular advantage over prior apparatus and methods in that they may be specifically tailored by the user to individual requirements. The apparatus and method according to the present invention may be used as an evaluation tool for neuromuscular performance, to stimulate different muscles and joints in a user, and allows exercise or treatment at different levels of force applied by a user.

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However, the apparatus and method according to the present invention is also suited for use in microgravity environments, for example beyond the earth's atmosphere, where exercising with weights, for example barbells, is ineffective.

5

An embodiment of the present invention will now be described in detail by way of example, with reference to the accompanying drawings, in which:

10 Figure 1 is a side view of a preferred embodiment of the apparatus according to the present invention; and
Figure 2 is a top view of the embodiment shown in Figure 1.

Referring to Figures 1 and 2, a preferred embodiment of the
15 apparatus of the present invention comprises first and second pressure sensors 2 and 4 respectively, in the form of first and second strain gauges, a control unit 6 to which pressure values sensed by the pressure sensors 2 and 4 are fed, and first and second vibrational stimulators 8 and 10 respectively
20 for applying vibrational stimulation to the user. The pressure values detected by the first and second pressure sensors 2 and 4 are fed to the control unit 6 via connections 12. The apparatus further comprises a touch screen display 14 by which the user may view in real time their performance on the
25 apparatus, and may input or change apparatus parameters, for example the threshold pressure value, or parameters of the vibrational stimulators 8 and 10.

As shown in Figures 1 and 2, the preferred embodiment of the
30 apparatus according to the present invention is designed for use by a supine user. The first pressure sensor 2 and first vibrational stimulator 8 form part of a unit which comprises a bar 16 against which the user pushes through their hands to

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apply pressure thereto. The second pressure sensor 4 and second vibrational stimulator 10 form part of a unit which comprises a plate 18 against which the user pushes through their feet to apply pressure thereto.

5

The bar 16 and/or plate 18 may be reciprocally moveable relative to a user in response to the first and/or second pressure sensors 2 and/or 4 respectively sensing an applied pressure which exceeds the threshold pressure. Thus, in the 10 embodiment shown in Figures 1 and 2, the bar 16 may be reciprocally moveable towards and away from the direction of applied pressure through the arms of the user (i.e. upwards and downwards in the view shown in Figure 1) and/or the plate 18 may be reciprocally moveable towards and away from the 15 direction of applied pressure through the feet of the user (i.e. left and right in the view shown in Figure 1). The direction, speed and magnitude of reciprocal movement of the bar 16 and plate 18 may be pre-determined by the user via the touch screen display 14.

20

Thus, in use, in the supine position the user initially applies pressure to the bar 16 and plate 18 to their maximum ability. These initial pressure values are sensed by the first and second pressure sensors 2 and 4, and are stored in 25 the control unit 6. The user then sets the threshold pressure value, for example 70% of the initial pressure value, using the touchscreen 14. The user then applies pressure to the bar 16 and plate 18, and whenever the first and second pressure sensors 2 and 4 sense pressure values greater than the 30 threshold value, the control unit 6 activates the first and second vibrational stimulators 8 and 10, to thereby stimulate the arm and leg muscles respectively of the user. When the pressure value sensed by the first and/or second pressure

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sensors 2 and 4 drops below the threshold pressure value, then the control unit 6 deactivates the first and/or second vibrational stimulators 8 and 10 accordingly. As referred to hereinabove, the bar 16 and/or plate 18 may be reciprocally 5 moveable relative to the user in response to the first and/or second pressure sensors 2 and/or 4 respectively sensing an applied pressure which exceeds the threshold pressure.

It will be understood that the embodiment illustrated 10 describes the invention in one form only for the purposes of illustration. In practice, the invention may be applied to many different configurations, the detailed embodiments being straightforward for those skilled in the art to implement.

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CLAIMS

1. Apparatus for muscular stimulation of a user, which apparatus comprises a pressure sensor, a control unit to which
5 pressure values sensed by the pressure sensor are fed, and a vibrational stimulator for applying vibrational stimulation, wherein the vibrational stimulator is activated by the control unit in response to the pressure sensor sensing an applied pressure which exceeds a threshold pressure value.
- 10 2. Apparatus according to claim 1 wherein the vibrational stimulator is deactivated when the pressure sensor ceases to sense an applied pressure which exceeds the threshold pressure value.
- 15 3. Apparatus according to claim 1 or 2 which comprises a first set of pressure sensors for detecting pressure applied through the hands of a user, and/or a second set of pressure sensors for detection of pressure applied through the feet of
20 a user.
4. Apparatus according to claim 3 which comprises both said first and second sets of pressure sensors.
- 25 5. Apparatus according to claim 3 or 4 wherein the first set of pressure sensors detects pressure applied to a bar against which a user can push or pull with their hands.
6. Apparatus according to any one of claims 3, 4 or 5
30 wherein the second set of pressure sensors detects pressure applied to a plate against which a user can push with their feet.

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7. Apparatus according to any preceding claim wherein the pressure sensor comprises a strain gauge.
8. Apparatus according to any preceding claim for use by a supine user.
9. Apparatus according to any preceding claim wherein the control unit comprises a central processing unit.
- 10 10. Apparatus according to any preceding claim wherein the control unit allows a user to set the frequency, amplitude and/or direction of vibrations generated by the vibrational stimulator, and/or stores information concerning use of the apparatus by a user.
- 15
11. Apparatus according to any preceding claim further comprising display means for viewing during use of the apparatus by a user.
- 20 12. Apparatus according to any preceding claim which comprises a corresponding number of vibration stimulators and pressure sensors.
13. Apparatus according to claim 12 which comprises a first vibrational stimulator associated with a first set of pressure sensors for detecting pressure applied through the hands of a user, and/or a second vibrational stimulator associated with a second set of pressure sensors for detecting pressure applied through the feet of a user.
- 25
- 30
14. Apparatus according to claim 13 wherein the first set of pressure sensors and first vibrational stimulator are associated with a bar against which a user can push or pull

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with their hands.

15. Apparatus according to claim 13 or 14 wherein the second set of pressure sensors and second vibrational stimulator are
5 associated with a plate against which a user can push with their feet.

16. Apparatus according to any preceding claim wherein the vibrational stimulator can deliver vibrational stimulation to
10 a user in a plurality of amplitudes, frequencies and/or directions.

17. Apparatus according to claim 16 wherein the vibrational stimulator comprises one or more individual vibration engines,
15 which are controlled electronically according to parameters stored by the control unit.

18. Apparatus according to claim 17 wherein the parameters are manually set by a user prior to use of the apparatus.
20

19. Apparatus according to any preceding claim wherein the vibrational stimulator(s) provide vibrational stimulation to a user via a unit which can reciprocally move relative to a user in response to the pressure sensor sensing an applied
25 pressure which exceeds the threshold pressure.

20. Apparatus according to claim 19 which comprises a bar to which a user can apply pressure through their hands, which bar is reciprocally moveable relative to the user.

30

21. Apparatus according to claim 19 or 20 which comprises a plate to which a user can apply pressure through their feet, which plate is reciprocally moveable.

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22. Apparatus according to claim 19, 20 or 21 wherein the reciprocal movement is substantially towards and away from a user in the plane of symmetry of the user, laterally in a plane substantially orthogonal to the plane of symmetry of a user, a combination of movements in both of said planes, circular movement in one or both of said planes, or a combination of any of such movements.

23. Apparatus according to any one of claims 19 to 22 wherein the direction(s), speed and/or magnitude of the reciprocal movement may be predetermined by the user via the control unit.

24. A method for muscular stimulation of a user, which method comprises the user applying an initial pressure which is sensed by a pressure sensor, recording the initial pressure value sensed by the pressure sensor, and applying vibrational stimulation to the user by a vibrational stimulator in response to the user applying pressure to the pressure sensor which exceeds a threshold pressure value determined by the initial pressure value.

25. A method according to claim 24 wherein the vibrational stimulation is provided to the user via a unit which reciprocally moves relative to the user in response to the user applying pressure to the pressure sensor which exceeds the threshold pressure value.

25. Apparatus substantially as hereinbefore described with reference to the accompanying drawings.

26. A method substantially as hereinbefore described.

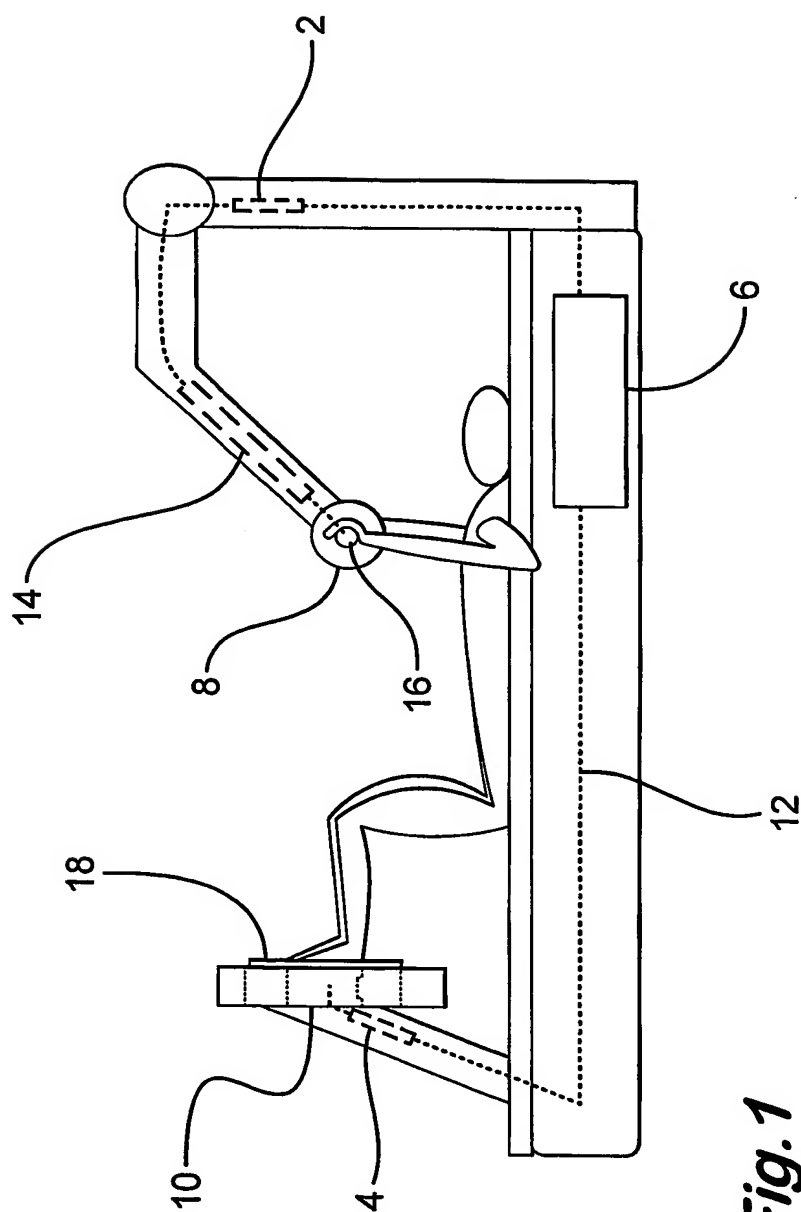


Fig. 1

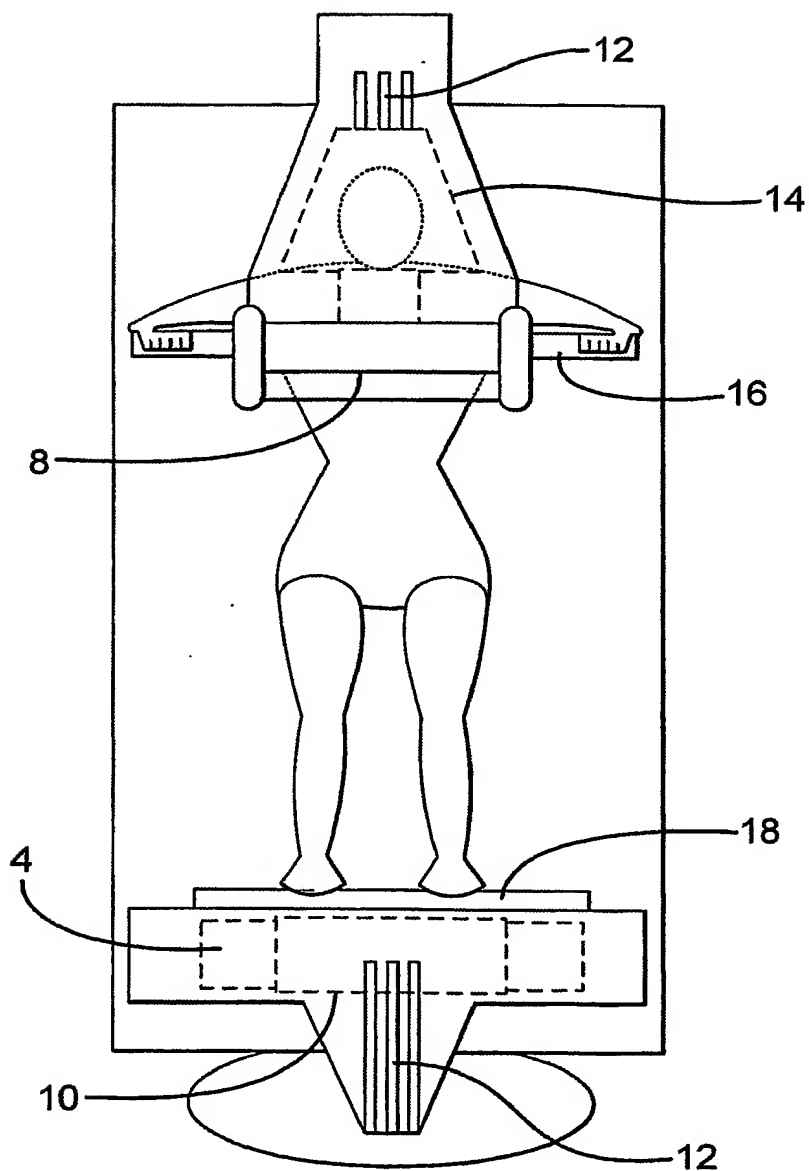


Fig.2

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AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,
CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH,
GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC,
LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW,
MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE,
SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ,
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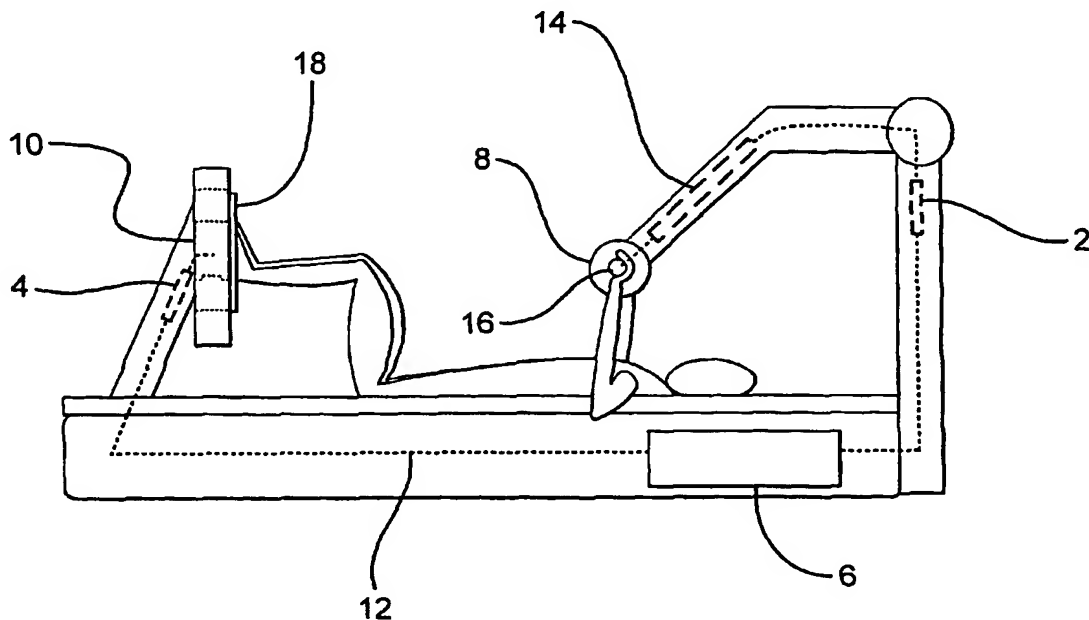
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KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),
Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,
ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO,
SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM,
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[Continued on next page]

(54) Title: APPARATUS AND METHOD FOR MUSCULAR STIMULATION



(57) Abstract: Apparatus for muscular stimulation of a user comprises a pressure sensor (2, 4), a control unit (6) to which pressure values sensed by the pressure sensor are fed, and a vibrational stimulator (8, 10) for applying vibrational stimulation. The vibrational stimulator is activated by the control unit in response to the pressure sensor sensing an applied pressure which exceeds a threshold pressure value.

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A. CLASSIFICATION OF SUBJECT MATTER

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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A61H A63B B64G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 02/053084 A (ARCTIC MEDICAL AS ;OLSEN OLE (NO); LEIVSETH GUNNAR (NO)) 11 July 2002 (2002-07-11)	1-7, 9-13, 15-19, 21-25
A	page 2, line 21 -page 7, line 8; figure 1	14
X	US 6 039 679 A (YU SIMON S C) 21 March 2000 (2000-03-21)	1-3, 8, 10-14, 16, 19, 20, 24
	column 2, line 36 -column 4, line 26; figures 1-4 --- -/--	



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *Z* document member of the same patent family

Date of the actual completion of the international search

28 May 2004

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Name and mailing address of the ISA

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Authorized officer

Oelschläger, H

INTERNATIONAL SEARCH REPORT

PCT/GB 03/03258

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1 121 956 A (BOSCO CARMELO) 8 August 2001 (2001-08-08) the whole document	1-3,6,9, 10,12, 13, 15-19, 21-25
A	EP 0 335 616 A (SHANKSTER RAYMOND EDWIN) 4 October 1989 (1989-10-04) the whole document	1,3,6, 15,19, 21-23
A	US 4 705 271 A (SKOVER JR NICK ET AL) 10 November 1987 (1987-11-10) column 2, line 52 -column 8, line 45; figures 1-9	1,3,5, 7-11,13, 14,19, 20,22,23
A	SU 1 447 385 A (MIKHEEV ALEKSANDR A ;NIGREEV VLADIMIR S (SU); KAZAKOV SERGEJ F (SU) 30 December 1988 (1988-12-30)	

INTERNATIONAL SEARCH REPORT

PCT/GB 03/03258

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
Although claims 24 and 25 are also directed to a method of treatment of the human/animal body, the search has been carried out.
2. ☒ Claims Nos.: 26, 27
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 26, 27

Claim number 25 is duplicated. Therefore, second claim 25 is renumbered to be claim 26; former claim 26 is renumbered to be claim 27.

These claims 26 and 27 have not been searched, since they do not meet the criteria of Rule 6.2(a) PCT.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

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